Blood pressure profile of school going adolescents (13-15 yrs): Relation with anthropometric variables and family history

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ABSTRACT

Introduction: Raised blood pressure in adolescents is an emerging public health problem and is recognised as one of the most important predictors of adult hypertension. The etiologic process for adult blood pressure abnormalities starts early in life.

Objectives: The present study's objective was to screen adolescents for blood pressure and further compare the data on anthropometric variables – weight, height, BMI and waist circumference as well as family history amongst pre-hypertensive, hypertensive, hypotensive and normotensive adolescents.

Methods: The present study assessed the prevalence of pre-hypertension, hypertension and hypotension among adolescents (n=500) of a public school in East Delhi, India; and investigated its association with anthropometric variables- weight, height, BMI and waist circumference, as well as family history. Adolescents were screened for blood pressure, weight, height, BMI, and WC, along with familial history of abnormal blood pressure.

Results: Prevalence of prehypertension, hypertension and hypotension was found to be 9.4%, 7.8% and 9.8%, respectively. The study showed an association of hypertension and prehypertension with BMI and waist circumference. A positive correlation was found between SBP and WC (r=0.3), SBP and BMI (r=0.28); DBP and WC (r=0.18), DBP and BMI (0.18). SBP and WC showed strongest correlation, indicating the role of WC in adolescent hypertension. The present study also indicates that while mean age for hypotensive adolescents is highest, their mean weight and height are the lowest. On the other hand, mean weight and height was highest for pre-hypertensive adolescents, followed by hypertensive adolescents suggesting that being overweight and obese is likely to increase the risk of developing hypertension. By BMI categorisation, obesity and overweight taken together, was present in 51% of pre-hypertensive and 48.6% of hypertensive adolescents, while hypotensive group had the highest percentage of thin adolescents (12.2%). Further, hypertensive and pre-hypertensive individuals had highest mean waist circumference. Family history of abnormal blood pressure levels was more in pre-hypertensive (36.1%) and hypertensive group (35.8%) than in hypotensive and normotensive adolescents.

Conclusion: These results substantiate an evolving endemic of cardiovascular risk in youth, as evidenced by the prevalence of hypertension and its association with obesity indicators. Evaluation of anthropometric variables and family history should form early entry points in the adolescent demographic in order to regulate blood pressure irregularities.

Keywords: *physical health, adolescent health, life-style disorders*

1. Introduction

Cardiovascular Disease (CVD), known to be one of the major causes of death in developed nations, is increasingly being recognised as a major killer in developing nations (Lozano et al., 2012). Hypertension exerts a substantial public health burden on cardiovascular health status and healthcare systems in India (Srinath et al., 2005). In India, hypertension is the leading non-communicable disease risk and estimated to be attributable for nearly 10% of all deaths (Patel et al. 2011). According to the UNICEF Report ("State of the World's Children", 2011), adolescents comprise approximately 18% of the world's population and India is home to more than 243 million adolescents, who account for a quarter of the country's population.

Although, hypertension is a problem of adults, its etiologic process starts early in life. The prevalence and rate of diagnosis of hypertension in children and adolescents appears to be increasing. Investigation of blood pressure in children can contribute not only to the knowledge of etiology of the condition, but more importantly, can also prevent high blood pressure before its harmful sequel can occur (Verma, Chhatwal & George, 1994). Research evidence shows that hypertension in adults has its origin in childhood (Anand et al., 2014; Moura et al., 2004, Chen and Wang, 2008), which is the leading cause of premature death worldwide (Chobanian, 2003). The prevalence of adolescent hypertension in India ranges from 0.6% to 21.5% (Amma GD et al., 2015; Sundar et al., 2013; Naha, John & Cherian, 2016). Adolescents with high blood pressure have a significantly greater clustering effect of metabolic syndrome factors and other adverse outcomes like hypertensive encephalopathy, seizures, and even cerebrovascular accidents and congestive heart failure, when compared to adolescents with low blood pressure (Bruce & Sanaiko, 2008). It has also been noted that even asymptomatic adolescents with mild blood pressure elevations can have target organ damage (Lurbe et al., 2005; Ejike & Ugwu, 2010).

Not just hypertension alone, but hypotension also is a cause of concern. Hypotension in adolescents can be linked to chronic fatigue, orthostatic dizziness, weakness, sleep disturbance, syncope or near syncope, headache, and loss of appetite (Tanaka et al., 1999). Low habitual systolic blood pressure has been associated with poor social, physical, and mental wellbeing as well as with a higher prevalence of anxiety and depression (Hildrum et al., 2007). Constitutionally, low blood pressure has been associated with diminished cognitive performance, mainly involving attention and reaction time (Wharton et al., 2005; Duschek & Schandry, 2007).

Hypertension in children and adolescents is defined as systolic BP (SBP) and/or diastolic BP (DBP) that is, on repeated measurement, at or above the 95th percentile. BP between the 90th and 95th percentile in childhood had been designated "high normal". The child is normotensive if the BP is below the 90th percentile (Falkner et al., 2000).

According to the National Heart, Lung, and Blood Institute of the National Institute of Health, hypotension refers to an abnormally low blood pressure. Sheih et al. (2012) has given two definitions to determine hypotension in adolescents:

i) BP below the 5th percentile or

ii) BP below two standard deviations (SDs) of the mean for age and gender.

It is well known that obesity is a key determinant of elevated blood pressure in children and adolescents. There is an increase in the prevalence of overweight & obesity in childhood (Chhatwal, Verma & Rial, 2004; Marwaha et al., 2006; Khadikar & Khadikar, 2004). Obesity is a significant determinant of pre-hypertension and hypertension among adolescents (Amma GD et

al., 2015). Indian children are more susceptible to obesity-mediated hypertension. Higher prevalence of hypertension along with higher adiposity has also been reported (Raj et al., 2007). According to Reddy et al. (2012), hypertension in students was found to be significantly associated with higher BMI and with family history of hypertension. Family history is a non-modifiable risk factor for abnormal blood pressure values. The hereditary nature of hypertension is well established by numerous family studies, which confirm associations of blood pressure among first-degree relatives and between parents and children (Barlassina et al., 2002; Carretero and Oparil, 2000).

The increasing incidence of non-communicable diseases will lead to greater dependency and mounting costs of care for patients and their families, unless public health efforts to prevent these conditions are intensified. The present study, therefore, aims to screen the adolescents for blood pressure and further compare the data on anthropometric variables – weight, height, BMI and waist circumference as well as family history amongst the pre-hypertensive, hypertensive, hypotensive and normotensive adolescents.

2. Materials and Methods

The study was a cross-sectional study on the adolescents (aged 13-15 years) of Delhi. The study consisted of two components - screening of adolescents based on their blood pressure profile into normotensive, pre-hypertensive, hypertensive and hypotensive, and then further comparison regard-ing the anthropometric parameters measured. Based on the prevalence of hypertension among adolescents in Delhi being 16.6% (Bahl, Singh & Sabharwal, 2015), the sample size was calculated as 500. A co-educational school in East Delhi was selected, using the Purposive sampling method. From the selected school, six sections from class VIIth to IXth were selected randomly. Permission for this study was obtained from Lady Irwin College Institutional Ethics Committee and Senior management of the School. Informed written consent was obtained from one of the child's parents and, in addition, assent was obtained from the child before conducting the study. Any subject suffering from other serious chronic conditions, on medication for some on-going illness or subjects with age less than 13 and greater than 15 years were not included in the study.

Data on general information was collected by using a pre-designed and pre-tested questionnaire. Anthropometric measures (height, weight, BMI and waist circumference) and BP data were obtained through physical examination, using standardised protocols and calibrated equipment. Height was measured up to 0.1cm sensitivity using Microtoise, using validated technique. Weight was recorded up to 100 g accuracy using Digital weighing balance, using validated technique (WHO, STEPS Surveillance). All the readings of height and weight were taken in duplicate and mean was calculated.

BMI was then calculated using this information. BMI cut-offs were identified using WHO reference graphs (2007). Non-stretchable flexible tape was used for measuring waist circumference, using validated technique (WHO, STEPS Surveillance). Waist circumference was divided into high and normal, based on the age and sex-specific waist circumference percentile values given by Kurian et al. (2011). Blood pressure was measured using Omoron Digital BP Monitor, using validated technique (WHO. STEPS Surveillance), wherein the instrument was to be on a level with the heart of the person whose BP is to be measured and the person's arm was put through the cuff loops. Arm was positioned correctly – the bottom edge of the cuff was at 1 or 2 cm above the elbow. Marker (arrow under tube) was centered on the middle of the inner arm. Velcro-fastener was closed when the cuff snugly encircled the upper arm.

START / STOP button was pressed. The reading of systolic, diastolic pressure, pulse rate was then noted down. Readings were taken again five minutes later. An average of the two BP readings was taken. Blood pressure classification by Banker et al. (2016) was used for BP classification, which is age-independent and uses gender and height.

3. Results & Discussion

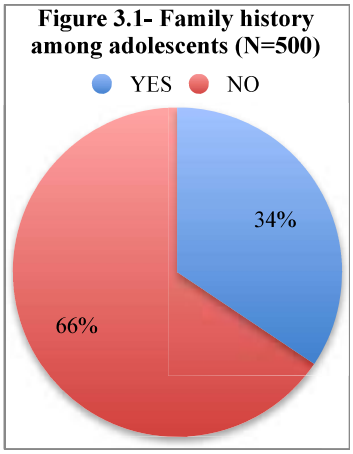
The Results and Discussion section of the study has been categorised and presented under the following heads-

I) Screening of adolescents (N=500) for BMI, WC and Blood Pressure-

a) Family history (FH) of abnormal blood pressure values-

In the present study, family history referred to a family history of both hypertension and/or hypotension. Figure 3.1 shows that a large number of the subjects (~35%) who participated in the study had a family history of either hypertension or hypotension.

Figure 3.1- Family history among adolescents (N=500)



b) BMI –

Figure 3.2 depicts BMI distribution among adolescents.

The reason for using BMI age and sex-specific percentiles for teens is that the amount of body fat is subject to change, with regards to age and gender (About Child and Teen BMI, CDC website).

57.8% adolescents were under the normal BMI range. While 23.2% of adolescents were overweight, obesity was seen in 9.2%. Percentage of adolescents found to be thin was 8.6% and severely thin was 1.2%. Similar findings have been reported by Chhatwal, Verma & Rial (2004) and Kajale et al. (2014). However, the prevalence of adolescent overweight in the present study was higher than the values reported by Mohan et al. (2004) (11.63%) and Bagudai, Nanda & Kodidala (2014) (10.4%). The prevalence of obesity among adolescents was higher than that reported by Mohan et al. (2004) (7.4%).

Figure 3.3 shows that a greater percentage of boys was found to be overweight and obese (35.5%) as compared to girls (26.8%), by BMI categorisation. Present study shows that 8.3% girls were thin. It is worth mentioning that when the outcomes of the present study were compared with the results obtained in two other studies, 68.52 % adolescent girls of Varanasi (Choudhary et al., 2003) and 69.3% subjects of Ratnagiri (Patil et al., 2009) were found to be underweight compared to only 8.3 % in the

Figure 3.3 - Gender wise distribution of BMI

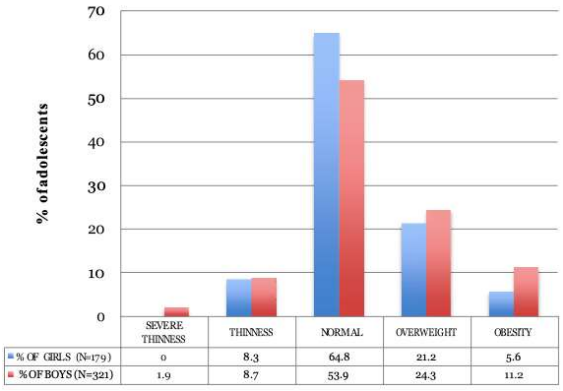
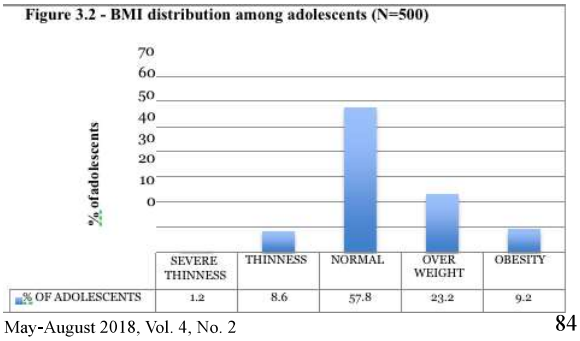


Figure 3.2 - BMI distribution among adolescents (N=500)

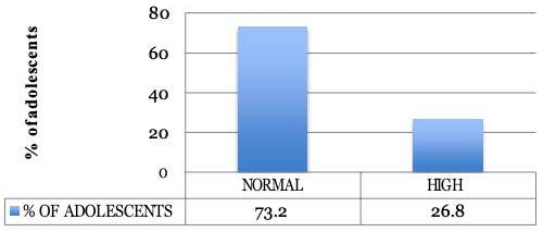


present study subjects. The lower figures of undernutrition in the subjects may be a result of urban habitation, which provides them more access to food and lesser physical activities compared to the above-mentioned rural girls. Out of the girls, 26.8% fell in the category of either overweight or obese. The percentage of overweight and obese girls (26.8%) in the present study was high compared to the Varanasi (Choudhary et al., 2003) and Ratnagiri (Patil et al., 2009) subjects' percentage of overweight and obese. These results indicate that urban adolescents and rural adolescents might have these discrepancies owing to the fact that urban adolescents have a more sedentary lifestyle, along with greater access to junk food.

c) Waist Circumference-

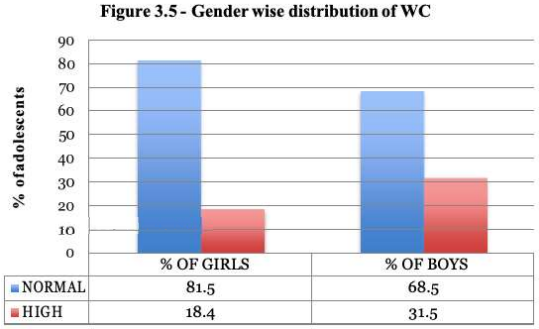
Almost one quarter of adolescents (26.8%) were found to have higher than normal waist circumference (Figure 3.4).

Figure 3.4 - WC distribution among adolescents (N=500)



Mean WC for boys (71.2± 10.1 cm) was greater than that of mean WC for girls (67.6 ± 9.4 cm). These findings coincide with those of Bahl, Singh & Sabharwal (2015). Figure 3.5, depicts that more boys (31.5%) than girls (18.4%) had high WC. This finding supports the earlier findings of more proportion of boys being overweight and obese. Higher central adiposity is linked to overweight and obesity, as corroborated by Ricardo, Caldeira & Catarina (2009), who reported a strong correlation between BMI and waist circumference (r = 0.90). Students with excess weight have a higher probability of abdominal obesity (Silva et al., 2011) and the current study confirms that. A significant difference between the WC of girls and boys was found (t=-3.8, p=0.00006, p<0.05).

Figure 3.5 - Gender wise distribution of WC



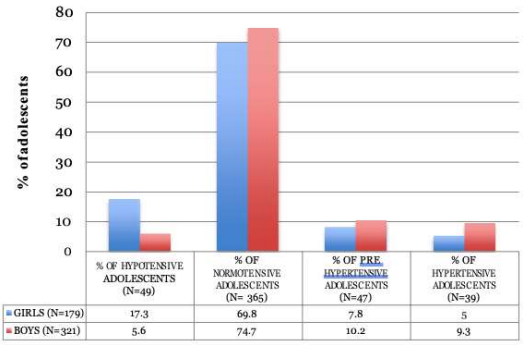
d) Blood Pressure–

Out of the screened adolescents (N=500), 365 were found to be normotensive, 47 were pre-hypertensive, 39 were hypertensive, and 49 were hypotensive. Prevalence of hypotension was 9.8%, prehypertension was 9.4% and hypertension was 7.8%. Other studies done on schoolchildren have reported the prevalence of hypertension as between 1-3.3% (Baradol et al., 2014; Sugiyama et al., 2007). However, some studies have also reported higher rates of prevalence. Bahl, Singh & Sabharwal (2015), found prevalence of pre-hypertension and hypertension to be 14% and 16.6%, respectively. In a study done by Deshpande (2014), pre-hypertension was noted in 15.9% and hypertension was noted in 13.9% adolescents. These differences in prevalence rates could be due to the different criteria adopted for blood pressure classification as well as basic geographical differences.

Mean SBP for girls was reported to be 104.6 ± 10.3 mm/Hg, while for boys, it was 108.9 ± 10.8 mm/Hg. Mean DBP for girls was 72.4 ± 7.0 mm/Hg and for boys was 73.8 ± 8.2 mm/Hg. Both mean SBP and DBP in the present study are higher in boys, which is supported by Amma, Vasudevan & Akshayakumar (2015). High WC and more prevalence of obesity, as reported above, may be linked to the higher blood pressure values among boys. Figure- 3.6 shows percentage of girls and boys among hypotensive, normotensive, pre hypertensive and hypertensive adolescents 17.3% girls as compared to 5.6% boys were hypotensive, indicating that girls in the present study had more tendencies for low blood pressure. Pre hypertension and hypertension was found to be more among boys.

With hypertension being almost double (9.3%) than that of girls (5%). This may be due to more overweight and obesity found among boys.

Figure 3.6 - Gender wise distribution among hypotensive, normotensive, pre hypertensive & hypertensive adolescents



II. Comparison of anthropometric indices and family history among hypotensive, normotensive, pre hypertensive and hypertensive adolescents.

a) Family history-

Following table 3.1 gives the information on the family history of blood pressure of normotensive, pre-hypertensive, hypertensive and hypotensive adolescents.

Table 3.1- Family history among hypotensive, normotensive, pre hypertensive & hypertensive adolescents (N=500)

	Hypotensive adolescents (n=49)	Normotensive adolescents (n=365)	Pre hypertensive adolescents (n=47)	Hypertensive adolescents (n=39)
Hereditary	16 (32.6)	125 (34.2)	17 (36.1)	14 (35.8)
Not hereditary	33 (67.3)	240 (65.7)	30 (63.8)	25 (64.1)

(Number in parentheses denotes percentage)

It was found that almost one-third of adolescents in all four groups, namely normotensive, pre-hypertensive, hypertensive and hypotensive groups, did have a history of abnormal blood pressure level in their families. However, although slightly high, this trend was more in pre-hypertensive (36.1%) and hypertensive group (35.8%), compared to the other two groups. Hereditary factors are known to increase the risk of hypertension (Ranasinghe et al., 2015).

b) Age, Weight & Height-

Mean age was found to be the greatest for hypotensive adolescents (14.3 ± 0.7 yrs), followed by normotensive and pre-hypertensive adolescents.

Mean height was found to be the greatest among pre-hypertensive adolescents (161.1 ± 9.1), followed closely by normotensive adolescents.

A positive correlation was found between SBP & height (r = 0.13) as well as between DBP & height (r= 0.17). Fujita et al. 2010 have also reported an association between height and blood pressure to be significant among adolescents.

Mean weight was found to be highest among the pre-hypertensive group (56.1 ± 14 kg), followed by hypertensive adolescents.

A positive correlation was found between SBP and weight (r = 0.29), and a positive correlation between DBP and weight was also found (r = 0.24). McGavok et al. (2007) reported a similar finding of overweight in adolescents being associated with elevated SBP.

Following Table 3.2 shows the distribution of mean age, mean weight and mean height across the four groups.

Table 3.2- Mean age (yrs.), mean weight (kg) & mean height (cm) among hypotensive, normotensive, pre hypertensive & hypertensive adolescents (N=500)

	Mean age ± sd (yrs)	Mean weight ± sd (kgs)	Mean height ± sd (cm)
Hypotensive adolescents (n=49)	14.3 ± 0.7	46.8 ± 7.8	155.1 ± 22.9

Normotensive adolescents (n=365)	13.9 ± 0.8	52.6 ± 13.3	160.5 ± 9.6
Pre hypertensive adolescents (n=47)	13.9 ± 0.8	56.1 ± 14	161.1 ± 9.1
Hypertensive adolescents (n=39)	13.3 ± 0.5	55.5 ± 15.9	156.6 ± 8.2

This indicates that while themean age for hypotensive adolescents is highest, their mean weight and height are the lowest. On the other hand, mean weight and height was highest for pre-hypertensive adolescents, followed by hypertensive adolescents, suggesting that being overweight and obese is likely to increase the risk of developing hypertension.

c) BMI-

Figure 3.7- BMI distribution among hypotensive, normotensive, pre hypertensive & hypertensive adolescents

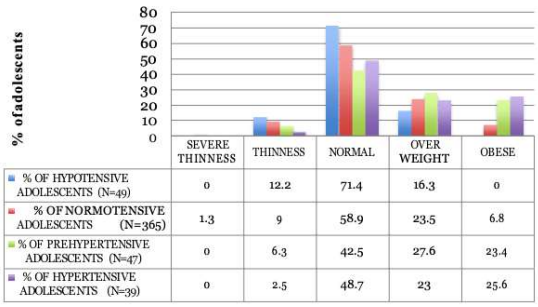


Figure 3.7 suggests that a greater percentage of adolescents falling under overweight or obese categories are pre-hypertensives or hypertensives. Both systolic and diastolic blood pressure were higher in the over-weight and obese group, as reported by Madhusudhan et al. (2016). These results suggest the role of body adiposity in high blood pressure, displayed by adolescents. Also, a higher percentage of thin adolescents are hypotensive. A positive correlation between SBP and BMI (r = 0.28) and DBP and BMI (r = 0.18) was also observed here. Similar findings have been reported by Dwivedi et al. (2016); Falaschetti et al. (2010); Larsson, Hernell & Lind (2011), and Ribeiro et al. (2003). Obesity should be treated as an indicator of a pre-disease condition, which may lead to blood pressure abnormalities among adolescents, pre-disposing them to other disease conditions like cardiovascular diseases.

d) Waist circumference –

Hypertensive and pre-hypertensive individuals had the highest mean waist circumference (73.6 ± 12.4 cm, 73.4 ± 9.7 respectively). This clearly indicates the possible role of high central adiposity in elevated blood pressure.

Table 3.3- WC distribution among hypotensive, normotensive, pre hypertensive & hypertensive adolescents (N=500)

Waist Circumference	No. of hypotensive adolescents (N=49)	No. of normotensive adolescents (N= 365)	No. of pre-hypertensive adolescents (N=47)	No. of hypertensive adolescents (N=39)
NORMAL	42 (85.7)	272 (74.5)	27 (57.4)	24 (61.5)
HIGH	7 (14.2)	93 (25.4)	20 (42.5)	15 (38.4)

Number in parantheses denotes percentage

Table 3.3 shows that among those who had a high WC, 42.5 % were pre-hypertensive. Dwivedi et al. (2016) has reported similar results where 38.92% children with high waist circumference had high SBP and 21.6% children with high waist circumference had high DBP. This suggests that a higher WC pre-disposes an adolescent to the risk of developing a high blood pressure.

Corresponding to our earlier findings, a positive correlation was found between SBP and WC (r=0.30) and DBP and WC(r=0.18). Adolescents with high WC, as indicators for central obesity, tend to have higher BP values (Al-Sendi et al., 2003). Zhao et al. (2017) also reported a strong

association between central adiposity and blood pressure among adolescents.

4. CONCLUSION-

Cardiological Society of India (CSI) in 2015 claimed that one in every three Indians was suffering from hypertension, with around 60% not being aware of their condition. Prevention should be started early in life. The present study explores if a relation exists between anthropometric variables, family history and blood pressure profiles of adolescents.

This study establishes a relation between obesity and/or overweight among adolescents and higher blood pressure values. Pre-hypertensive and hypertensive adolescents showed a greater tendency to have higher WC and to be overweight and obese. Familial history was also seen to be associated with the etiology of the disease.

Abnormal blood pressure, be it hypertension or hypotension, is known to be first diagnosed and thought seriously about only in early adulthood. Many adults do not even consider getting themselves checked until early signs start showing up, and then there is no scope for prevention. Being consciously aware about family history and anthropometric risk factors related to abnormal blood pressure can give us the opportunity to examine and/or prevent the condition way before the diagnosis is made.

It is, therefore, important to establish entry points at an earlier age, that is, in adolescence, and assess the risk factors associated with blood pressure irregularities like obesity or even under-nutrition in order to prevent it.This will not only greatly minimise out-of-pocket medical expenditure, but will also improve productivity and the quality of life. We also recommend initiating blood pressure monitoring during adolescence, in order to incorporate remedial measures as early on in life as possible.

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